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FULL CONTENTS CLAIM + DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

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CLAIM + DETAILED DESCRIPTION

[Claim(s)]

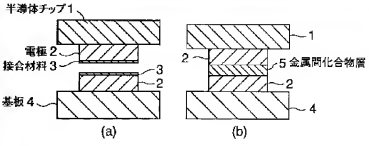
[Claim 1] In the semiconductor device electrically connected so that the 1st electrode on a semiconductor chip and the 2nd electrode on a substrate might counter mutually, [the 1st electrode of the above, and the 2nd electrode of the above] The semiconductor device characterized by being joined through the intermetallic compound layer formed of a desired electrode material and the charge of a jointing material supplied to at least one side of said 1st and 2nd electrodes.

[Claim 2] Said 1st electrode and the 2nd electrode of the above are the semiconductor devices of Claim 1 characterized by having the same form.

[Claim 3] The form of said 1st and 2nd electrodes is the semiconductor device of Claim 2 characterized by being convex form.

[Claim 4] The size of said 1st electrode and the size of the 2nd electrode of the above are the semiconductor devices of

Drawing selection Representative draw



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Claim 1 characterized by differing mutually.
[Claim 5] The semiconductor device of Claim 4 characterized by for one form of said 1st and 2nd electrodes being a concave, and the form of the electrode of another side being convex.
[Claim 6] The semiconductor device of Claim 1 characterized by having the structure where were embedded at said semiconductor chip so that said 1st and 2nd electrodes might project and might be formed from said semiconductor chip surface, and said charge of a jointing material was supplied to all the surfaces of said projected electrode, 2, or 4.
[Claim 7] The semiconductor device of Claim 1 characterized by having the structure where were embedded at said semiconductor chip so that said 1st and 2nd electrodes might project and might be formed from said semiconductor chip surface, and said charge of a jointing material was supplied only to the upper surface of said projected electrode, 2, or 4.
[Claim 8] One semiconductor device of Claim 1 characterized by supplying the charge of a jointing material supplied to at least one side of said 1st and 2nd electrodes to the field of a small opening area, and consisting of said electrode surface products to 7.
[Claim 9] Said substrate is one semiconductor device of 8 from Claim 1 characterized by being a semiconductor chip.
[Claim 10] One semiconductor device of Claim 1 to 9 with which said electrode material is characterized by said charge of a jointing material being tin by copper or a copper alloy.
[Claim 11] One semiconductor device of Claim 1 characterized by for said electrode material being the material chosen from either nickel, gold or those alloys, and being the material as which said charge of a jointing material was chosen from tin and indium, antimony, and palladium to 10.
[Claim 12] In the manufacture method of the semiconductor device electrically connected so that the 1st electrode on a semiconductor chip and the 2nd electrode on a substrate might be formed of a desired electrode material and it might counter mutually The manufacture method of the semiconductor device characterized by forming the desired charge of a jointing material on at least one electrode of the 1st and 2nd electrodes of the above, forming an intermetallic compound layer by diffusion between the above-mentioned electrode material and the above-mentioned charge of a jointing material, and joining the 1st electrode of the above, and the 2nd electrode of the above through this intermetallic compound layer.
[Claim 13] Said charge of a jointing material is the manufacture method of the semiconductor device of Claim

12 characterized by being formed in both 1st and 2nd electrodes.
[Claim 14] Said charge of a jointing material is formed in the field of an opening area smaller than the area of said electrode. Claim 12 or the manufacture method of the semiconductor device of 13 characterized by forming an intermetallic compound layer by diffusion between the above-mentioned electrode material and the above-mentioned charge of a jointing material, and joining the 1st electrode of the above, and the 2nd electrode of the above through this intermetallic compound layer.
[Claim 15] Said intermetallic compound layer is the manufacture method of one semiconductor device of 14 from Claim 12 characterized by being formed so that the above-mentioned charge of a jointing material may not remain in a junction interface, when said charge of a jointing material diffuses all in said electrode material.
[Claim 16] Said charge of a jointing material is the manufacture method of one semiconductor device of 15 from Claim 12 characterized by being a single metal material which can be diffused to said electrode material.
[Claim 17] In the manufacture method of the semiconductor device electrically connected so that the 1st electrode on a semiconductor chip and the 2nd electrode on a substrate might be formed of a desired electrode material and it might counter mutually On at least one electrode of the 1st and 2nd electrodes of the above, the desired charge of a jointing material is formed thinly. By carrying out position ****** of the 1st electrode of the above, and the 2nd electrode of the above, carrying out pressurization contact of the above 1st and the 2nd electrode through the above-mentioned charge of a jointing material, and holding, where the above-mentioned charge of a jointing material is heated and heated The manufacture method of the semiconductor device characterized by making it spread until all the charges of a jointing material form electrode material and an intermetallic compound, and joining the 1st electrode of the above, and the 2nd electrode through this intermetallic compound layer.
[Claim 18] Embed said 1st and 2nd electrodes at said semiconductor chip, and said semiconductor chip is ground. The manufacture method of one semiconductor device of Claim 12 characterized by making said electrode project and supplying said charge of a jointing material to the whole surface of said electrode by which projection formation was carried out by processing said semiconductor chip alternatively by dry etching to 17.
[Claim 19] By embedding said 1st and 2nd electrodes at said semiconductor chip, grinding said semiconductor chip, supplying said charge of a jointing material to said said

electrode upper surface ground and exposed, and processing said semiconductor chip alternatively by dry etching The manufacture method of one semiconductor device of Claim 12 characterized by said charge of a jointing material making said electrode supplied to the upper surface project to 18.
[Claim 20] The manufacture method of one semiconductor device of Claim 12 characterized by coming to supply [the field of an opening area smaller than said electrode surface product] the charge of a jointing material supplied to at least one side of said 1st and 2nd electrodes to 19.
[Claim 21] Said pressurization temperature is the manufacture method of one semiconductor device of 20 from Claim 12 characterized by being more than the melting point of said charge of a jointing material.
[Claim 22] Said pressurization temperature is the manufacture method of one semiconductor device of 21 from Claim 12 which is below the melting point of said charge of a jointing material, and is characterized by forming said intermetallic compound by solid phase diffusion.
[Claim 23] The manufacture method of one semiconductor device of Claim 12 which is made to carry out post-pressurization contact and is characterized by the thing for which the bonded surface of said 1st and 2nd electrodes was activated, and which heat to 22.
[Claim 24] The manufacture method of the semiconductor device of Claim 23 characterized by performing said activation processing by irradiating the gas of either the argon excited by plasma, oxygen or fluoride.

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the semiconductor device electrically connected so that the electrode on a semiconductor chip and the electrode on a substrate might counter mutually, and its manufacture method. It is related in particular with the junction structure of a semiconductor device, and the junction method of a semiconductor device.
[0002]
[Description of the Prior Art] Generally in flip chip mounting of a semiconductor chip, the metal junction by the plural alloy solder which made the main ingredients the solder of an alloy or Sn of 2 yuan for which the connection structure for obtaining electric connection used Sn and Pb is used.
[0003] There is structure called C4 (control KORAPPUSU

chip connection) as structure known especially well.
[0004] This conventional junction structure is shown in drawing 11 .
[0005] [the electrode 2 of the semiconductor chip 1, and the electrode 2 of a substrate 4 which carries out chip loading] Barrier metals, such as Cu, nickel, etc. with good solder ******, are used, the solder 20 constituted by Sn and Pb is supplied by the technique by plating or sputtering on an electrode 2, and heating melting is once carried out, and it forms spherically on an electrode 2.
[0006] Thus, while carrying out position ****** of the semiconductor chip 1 which had the solder bump formed and carrying it to a substrate 4, heating fusion is carried out and solder 20 is joined by solder. Cu of an electrode and Sn of solder form the intermetallic compounds 5a and 5b, the junction structure acquired here is connected, and electric connection of the semiconductor chip 1 and the substrate 2 is made through solder 20.
[0007] Solder 20 forms the semiconductor chip 1 and the gap of a substrate 4, and has the duty which eases the stress concentration by the thermal expansion difference of the semiconductor chip 1 and a substrate 4. When solder 20 is used as a SnPb eutectic crystal, it is made the electrode 2 of the semiconductor chip 1 with nickel or the barrier metal of CrCu/Cu, and when using Pb95%Sn5% of high-melting point solder, the barrier metal of Cu is used.
[0008] There is an advantage that it is joinable with heating without imposing load on an electrode 2 1, i.e., a semiconductor chip, according to this C4 junction, and it is suitable for mounting of the area array semiconductor chip with which the electrode has been arranged in the circuit side.
[0009] moreover -- in the connection structure for obtaining electric connection of flip chip mounting -- as other conventional technology -- Au -- a stud -- the sticking-by-pressure technology of Au bump who uses a bump is mentioned.
[0010] The conventional junction structure by this sticking-by-pressure technology is shown in drawing 12 .
[0011] the stud which used Au wire bonding on the electrode 24 of the semiconductor chip 1 -- a bump 23 is formed, Au plating 22 is given to the electrode of the partner board 4 to carry, and connection of Au(s) is obtained by heating and pressurization.
[0012] According to this technology, the electrode 24 of the semiconductor chip 1 can use the same aluminum electrode as the usual case, and since Au is a material which hardly oxidizes, it has an advantage joinable by simple heating and pressurization.
[0013] The connection (refer to drawing 11) by the above

C4 has a problem on the reliability in high temperature storage or a temperature cycle in the electrode of a semiconductor chip, and the interface of solder.
[0014] When eutectic crystal solder is used and Cu is used for an electrode, there is a problem that solder dissolves the electrode of a semiconductor chip and adhesion with an electrode ground deteriorates by heating of the repetition at the time of a package assembly and package mounting.
[0015] Furthermore, since aluminum usually used cannot use it as an electrode, and the electrode of special specification is required, cost becomes high.
[0016] Moreover, [connection] even if the C4 connection which uses eutectic crystal solder under the high temperature environment is the barrier metal of special specification An intermetallic compound layer is formed by the solid phase diffusion reaction of a barrier metal and Sn. Since Sn which is dissolving to Sn and Pb which constitute the solder near the interface at this time is spread, the segregation of Pb happens near an intermetallic compound layer, and the problem that Pb layer which carried out the segregation to the intermetallic compound layer which differs in a mechanical property extremely serves as a starting point of destruction by the stress concentration by a temperature cycle occurs.
[0017] on the other hand -- Au -- a stud -- although the usual aluminum electrode can be used in the sticking-by-pressure junction (refer to drawing 12) which uses a bump -- Au -- a stud -- it is at the time of bump formation, and in order to use load and an ultrasonic wave together, a shock starts greatly.
[0018] Moreover, although the same structure can be formed using Au plating, in order to carry out plastic deformation of the bonded surface and to take out sufficient faying surface, it is necessary to impose a very high temperature of 300 degrees C - 400 degrees C, and high load at the time of junction, and to join.
[0019] Therefore, it is difficult for there to be a possibility of causing destruction or change of the characteristic a semiconductor chip, and to apply it to a semiconductor chip, especially the area array semiconductor chip with which the electrode was formed in the circuit side.
[0020]
[Problem to be solved by the invention] Then, this invention is accomplished in view of the problem of the above-mentioned conventional technology, and there is a place made into the purpose in offering the stable junction structure which spoils reliability by neither high temperature storage nor a temperature cycle in the junction structure of a semiconductor chip, and does not have a defect.
[0021] Moreover, other purposes of this invention are to

offer the method of manufacturing the stable junction structure which spoils reliability by neither high temperature storage nor a temperature cycle in the junction structure of a semiconductor chip, and does not have a defect with low load and low cooking temperature.
[0022]
[Means for solving problem] In the semiconductor device electrically connected in this invention so that the 1st electrode on a semiconductor chip and the 2nd electrode on a substrate might counter mutually, [the 1st electrode of the above, and the 2nd electrode of the above] It is joined through the intermetallic compound layer formed of a desired electrode material and the charge of a jointing material supplied to at least one side of said 1st and 2nd electrodes.
[0023] In this case, as for said 1st electrode and the 2nd electrode of the above, it is desirable to have the same form.
[0024] The form of said 1st and 2nd electrodes is convex form, for example.
[0025] The size of said 1st electrode and the size of the 2nd electrode of the above may differ mutually.
[0026] For example, one form of said 1st and 2nd electrodes is a concave, and the form of the electrode of another side is convex.
[0027] Preferably, said 1st and 2nd electrodes are embedded at said semiconductor chip so that it may be projected and formed from said semiconductor chip surface, and they have the structure where said charge of a jointing material was supplied to all the surfaces of said projected electrode.
[0028] Said 1st and 2nd electrodes are embedded at said semiconductor chip so that it may be projected and formed from said semiconductor chip surface, and they may have the structure where said charge of a jointing material was supplied only to the upper surface of said projected electrode.
[0029] As for the charge of a jointing material supplied to at least one side of said 1st and 2nd electrodes, it is desirable for the field of a small opening area to be supplied and to consist of said electrode surface products.
[0030] Here, said substrate may be a semiconductor chip.
[0031] Said electrode material is copper or a copper alloy, and it is desirable that said charge of a jointing material is tin.
[0032] Said electrode material is the material chosen from either nickel, gold or those alloys, for example, and is the material as which said charge of a jointing material was chosen from tin and indium, antimony, and palladium.
[0033] Moreover, it sets to the manufacture method of the semiconductor device electrically connected so that the 1st electrode on a semiconductor chip and the 2nd electrode on

a substrate might be formed of a desired electrode material and it might counter mutually in this invention. The desired charge of a jointing material is formed on at least one electrode of the 1st and 2nd electrodes of the above, an intermetallic compound layer is formed by diffusion between the above-mentioned electrode material and the above-mentioned charge of a jointing material, and the 1st electrode of the above and the 2nd electrode of the above are joined through this intermetallic compound layer.

[0034] Here, said charge of a jointing material is preferably formed in both 1st and 2nd electrodes.

[0035] As for said charge of a jointing material, it is desirable for it to be formed in the field of an opening area smaller than the area of said electrode, to form an intermetallic compound layer by diffusion between the above-mentioned electrode material and the above-mentioned charge of a jointing material, and to join the 1st electrode of the above and the 2nd electrode of the above through this intermetallic compound layer.

[0036] When said charge of a jointing material diffuses all in said electrode material, said intermetallic compound layer is formed so that the above-mentioned charge of a jointing material may not remain in a junction interface.

[0037] Said charge of a jointing material is a single metal material which can be diffused to said electrode material, for example.

[0038] Moreover, it sets to the manufacture method of the semiconductor device electrically connected so that the 1st electrode on a semiconductor chip and the 2nd electrode on a substrate might be formed of a desired electrode material and it might counter mutually in this invention. On at least one electrode of the 1st and 2nd electrodes of the above, the desired charge of a jointing material is formed thinly. By carrying out position ****** of the 1st electrode of the above, and the 2nd electrode of the above, carrying out pressurization contact of the above 1st and the 2nd electrode through the above-mentioned charge of a jointing material, and holding, where the above-mentioned charge of a jointing material is heated and heated It is made to be spread until all the charges of a jointing material form electrode material and an intermetallic compound, and the 1st electrode of the above and the 2nd electrode are joined through this intermetallic compound layer.

[0039] In this case, it is desirable to embed said 1st and 2nd electrodes at said semiconductor chip, to grind said semiconductor chip, to make said electrode project by processing said semiconductor chip alternatively by dry etching, and to supply said charge of a jointing material to the whole surface of said electrode by which projection formation was carried out.

[0040] Or said 1st and 2nd electrodes are embedded at said semiconductor chip. Said charge of a jointing material may make said electrode supplied to the upper surface project by grinding said semiconductor chip, supplying said charge of a jointing material to said said electrode upper surface ground and exposed, and processing said semiconductor chip alternatively by dry etching.
[0041] For example, it comes to supply [the field of an opening area smaller than said electrode surface product] the charge of a jointing material supplied to at least one side of said 1st and 2nd electrodes.
[0042] As for said pressurization temperature, it is desirable that it is more than the melting point of said charge of a jointing material.
[0043] Said pressurization temperature is below the melting point of said charge of a jointing material, and may form said intermetallic compound by solid phase diffusion.
[0044] Moreover, after activating the bonded surface of said 1st and 2nd electrodes, pressurization contact is carried out, and you may make it heat.
[0045] It is desirable that said activation processing is performed by irradiating the gas of either the argon excited by plasma, oxygen or fluoride.
[0046]
[Function] [the junction structure by this invention] in order to obtain the electric connection between the electrode of a semiconductor chip, and the electrode of a substrate It is characterized by being the structure joined by this intermetallic compound layer, without spreading all the charges of a jointing material, becoming an intermetallic compound layer, and the layer of the charge of a jointing material remaining in a junction interface by diffusion of electrode material and the charge of a jointing material.
[0047] According to this invention, an intermetallic compound layer is the precise interface in which the interface with an electrode was formed of diffusion, and intensity becomes high compared with the former.
[0048] Moreover, since all junction material layers are changed into the intermetallic compound layer, there is no structural change which changes from the elastic charge of a jointing material to an intermetallic compound layer like before at the time of real use in hot environments and temperature cycle environment.
[0049] Furthermore, since all the charges of a jointing material are spread, a junction without defects, such as a segregation, can obtain them and they have the effect said that reliability improves.
[0050] The junction method of this invention makes single metal material which can be diffused the charge of a jointing material to electrode material. The charge of a jointing

material is supplied on an electrode very thinly, and it is the junction method characterized by joining all the charges of a jointing material by an intermetallic compound layer diffusion and by pressurizing and heating until it makes it intermetallic-compound-ize after position ****.

[0051] According to this method, it becomes possible to obtain a reliable junction, without applying load very short [time / for diffusing the charge of a jointing material].

[0052]

[Mode for carrying out the invention] The form of operation of this invention is explained in full detail below, referring to Drawings.

[0053] (Form of the first operation) Reference of drawing 1 shows the sectional view of the junction as a form of 1 operation of this invention. Drawing 1 (a) shows the sectional view before junction, and drawing 1 (b) shows the sectional view after junction, respectively.

[0054] By Cu, the electrode of a substrate 4 is also Cu and, as for the charge 3 of a jointing material, the electrode 2 of the semiconductor chip 1 is constituted from drawing 1 (a) by Sn. Position ****** of this electrode 2 is carried out, the grade which all Sn sides contact is pressurized, and Sn is heated more than a predetermined temperature.

[0055] A reaction progresses, Sn and Cu of an electrode 2 which are a charge of a jointing material form an intermetallic compound layer, and junction completes them. All Sn(s) contribute to alloying with Cu, and the composition of the obtained junction will be in the state where the electrode of Cu is joined by the CuSn intermetallic compound layer 5. Several sorts of intermetallic compounds from which the composition ratio of Cu and Sn differs in the intermetallic compound 5 are formed in layers.

[0056] although drawing 2 diffuses Sn into Cu by heating, in order that it may make Sn concentration gradient in a layer uniform -- such -- being stratified (5a, 5b, 5c) -- when it grew up and goes and diffusion fully progresses, it is the sectional view showing becoming a single intermetallic compound layer.

[0057] Since the junction of Cu and Sn in which drawing 1 and drawing 2 were formed in this way in both cases is a 2 yuan alloy, Without generating a segregation layer like the junction joined by diffusion with the SnPb alloy, since it is the alloy layer which inclined uniformly from the interface, it is very reliable to the stress from the outside.

[0058] Here, although the partner who joins to the semiconductor chip 1 is a substrate 4, he is possible also for connecting semiconductor chip 1 comrades, and has the same effect.

[0059] Furthermore, although it heats and the intermetallic compound layer 5 is formed by diffusion, pressurizing as the junction method, it is the process of temporary junction, and pressurization and heating may bundle up after this process, may heat at predetermined temperature by a heating layer, and may form the intermetallic compound layer 5 by diffusion.
[0060] Moreover, above, although the bonded surface of the electrode is not pretreating, before it pressurizes and heats an electrode as a pretreatment of junction, it may join by argon, oxygen, or fluoride irradiating the gas excited by plasma, and removing a surface organic matter or an oxide.
[0061] (Form of the second operation) Drawing 3 is the sectional view showing the form of operation of the second of this invention.
[0062] As what is different in the size of two electrodes 2a and 2b to join, and which face, even if one electrode 2a is a concave-like, it is considered as the structure where positive contact is obtained by using the electrode 2b of another side as the convex type electrode of the size below the shape of a concave of the electrode 2a.
[0063] The electrode 2a shown by drawing 3 is an electrode manufactured by the sputtering method, and in order to use etching, the level difference of the wiring covered by the insulating film 10 appears to the electrode 2a upper part. Since the electrode 2b of an area smaller than this level difference was formed by the electroless deposition method, the surface of Electrode 2b serves as convex form, and desired connection structure can make it.
[0064] Here, in drawing 3 , although supplied only on Electrode 2a, even if both both [one side or] which face are supplied, the effect does not change the charge 3 of a jointing material, as it is shown in drawing 4 and drawing 5 . More specifically by drawing 4 , the charge 3 of a jointing material is supplied only to the direction of Electrode 2b.
[0065] On the other hand by drawing 5 , the charge 3 of a jointing material is supplied to both Electrode 2a and the electrode 2b.
[0066] Here, in order to obtain the convex-shaped electrode 2b, how to depend on electroless deposition was shown, but even when film thickness is thickened by an electrolytic plating method, the same form can be acquired and may obtain a convex-shaped electrode by the other methods.
[0067] (Form of the third operation) Drawing 6 is the sectional view showing the form of operation of the third of this invention.
[0068] It is also possible for the electrode whose electrodes 2a and 2b which face are isomorphous [-like] to be manufactured by electroless deposition, and to obtain the

junction of this invention using a convex-shaped electrode in both cases.

[0069] In this case, although the charge 3 of a jointing material is supplied on Electrode 2a and Electrode 2b, even if one side of the electrode which faces is supplied, that effect does not change, as shown in drawing 7 . In drawing 7 , the charge 3 of a jointing material is supplied to the way of Electrode 2a.

[0070] Here, in order to obtain the convex-shaped electrode 2b, how to depend on electroless deposition was shown, but even when film thickness is thickened by an electrolytic plating method, the same form can be acquired. moreover, a stud -- you may obtain a convex-shaped electrode by the bump and the other methods.

[0071] Furthermore, in the case of the projected electrode, although the supply form of the charge 3 of a jointing material is supplied the whole surface on an electrode 2, as shown in drawing 8 , the case where the side is covered is sufficient as it, and it may be supplied to an area smaller than the electrode upper surface. In addition, you may be the form trickled by hemisphere form on the electrode.

[0072] Moreover, the penetrated electrode 2 is formed and it joins as it forms an electrode 2 in the back of a semiconductor chip, and it is shown in drawing 9 , when [two or more] it mounts the semiconductor chip 1 more than one.

[0073] First, an electrode 2 is embedded at the semiconductor chip 1 (drawing 9 (a)).

[0074] And the embedded electrode 2 is ground from the back and the surface of an electrode 2 is exposed (drawing 9 (b)).

[0075] Then, silicon is alternatively etched at a dry etching process, and the projection electrode 2 is formed (drawing 9 (c)).

[0076] Then, by non-electrolyzed tinning, the whole surface of the projected electrode 2 is plated, the charge 3 of a jointing material is supplied, and it joins as an electrode 2 (drawing 9 (d)).

[0077] On the other hand by drawing 10 , an electrode is embedded first at the semiconductor chip 1 (drawing 10 (a)).

[0078] And the embedded electrode 2 is exposed according to a polish process (drawing 10 (b)).

[0079] Next, the charge 3 of a jointing material is supplied to the upper surface of an electrode 2 by non-electrolyzed tinning (drawing 10 (a)).

[0080] Then, silicon is alternatively etched by dry etching and it joins as an electrode 2 (drawing 10 (d)).

[0081] With the form of operation mentioned above, although an electrode is Cu and the composition said to the charge of a jointing material as Sn shows it, In is mentioned that what is necessary is just the material which forms diffusion and an intermetallic compound layer to Cu of an electrode as a charge of a jointing material.
[0082] Moreover, although not formed, since nickel which carries out all the rate dissolution forms a single alloy, the material which forms intermetallic compounds, such as Sb and Pd, although the temperature of connection becomes high, and the intermetallic compound can acquire this junction structure.
[0083] Moreover, nickel, Au, etc. can be chosen as an electrode and those electrode material and the charge of a jointing material which forms an intermetallic compound are chosen in that case.
[0084]
[Working example] Next, the work example of this invention is explained with reference to drawing 1 .
[0085] At drawing 1 (a), the electrode 2 of the semiconductor chip 1 is Cu, and is 5 micrometers in thickness, the electrode 2 of a substrate 4 has the thickness of Cu18micrometer, and the charge 3 of a jointing material consists of thickness whose Sn(s) are 0.5 micrometer.
[0086] After carrying out position ****** of the electrode 2, it pressurizes by the load which all Sn sides contact, and heats at 300 degrees C which is more than the melting point of Sn. Sn reacts with Cu of an electrode 2 and forms a solid solution or an intermetallic compound layer one by one with a reaction.
[0087] The melting point solid-phase-izes the junction which it was high temperature of 300 degrees C or more, was heated at the beginning more than the melting point, and was the liquid phase, and junction completes the intermetallic compound 5 formed of the reaction. All Sn(s) contribute to alloying with Cu, and the composition of the obtained junction will be in the state where the electrode 2 of Cu is joined by the CuSn intermetallic compound layer 5.
[0088] Several sorts of intermetallic compounds from which the composition ratio of Cu and Sn differs in the intermetallic compound 5 are formed in layers. Drawing 2 is the structure of the junction obtained by carrying out heating continuation of the above-mentioned state further.
[0089] although Sn is diffused into Cu by heating, in order to make Sn concentration gradient in a layer uniform -- such -- being stratified (5a, 5b, 5c) -- it grows up and goes, and when diffusion fully progresses, it becomes the single intermetallic compound layer 5.
[0090] [the junction of Cu and Sn formed in this way in both / of drawing 1 and drawing 2 / cases] Without

generating a segregation layer like the junction joined by diffusion with the SnPb alloy, since it is a 2 yuan alloy, since it is the alloy layer which inclined uniformly from the interface, it is very reliable to the stress from the outside.
[0091] [here / thickness] although the thickness of Sn layer supplied has adopted 0.5 micrometer, also when there is 0.5-micrometer or more a thickness of 1-2 micrometers by cooking time or diffusion time Moreover, although based also on the flat nature of an electrode surface, if the electrode surface is able to contact, even a thickness of 0.5 micrometer - 0.1 micrometer or less is possible for formation of the junction of this invention.
[0092] Furthermore, although the partner who joins the semiconductor chip 1 here is considering it as the substrate 2, with the semiconductor chip 1, if the thickness of an electrode 2 is the same as the thickness of the semiconductor chip 1 to carry, it can join, and has the same effect.
[0093] Moreover, although cooking temperature after pressurization was carried out to more than the melting point of Sn here and 300 degrees C is selected, the junction structure of this invention can be acquired also at the temperature below the melting point. When cooking temperature is 180 degrees C, Sn of the charge 3 of a jointing material does not fuse, but forms the intermetallic compound layer 5 by the diffusion reaction in Cu and the solid phase of an electrode.
[0094] In this case, it has the effect that the uniform intermetallic compound layer 5 of what requires time for formation of a junction in order not to form a solid solution since it will not be in the state of the liquid phase, but to form the intermetallic compound layer 5 one by one can be formed.
[0095] In addition, it is clear that this invention is not limited to the form and work example of each above-mentioned implementation, but it may be suitably changed within the limits of the technical thought of this invention.
[0096]
[Effect of the Invention] According to this invention, in order to obtain the electric connection between the electrode of a semiconductor chip, and the electrode of a substrate, by diffusion of electrode material and the charge of a jointing material, all the charges of a jointing material diffuse junction structure, it serves as an intermetallic compound layer, and is joined by this intermetallic compound layer, without the layer of the charge of a jointing material remaining in a junction interface. With this structure, an interface with an electrode is a precise interface formed of diffusion, and an intermetallic compound layer is effective in intensity becoming high compared with the former.
[0097] Since all junction material layers are changed into

the intermetallic compound layer, moreover, hot environments, There is no structural change which changes from the elastic charge of a jointing material to an intermetallic compound layer like before at the time of real use in temperature cycle environment, and since all the charges of a jointing material are spread, a junction without defects, such as a segregation, can obtain them and they have the effect that reliability improves.

[0098] Furthermore, the junction method of this invention makes single metal material which can be diffused the charge of a jointing material to electrode material. [supply the charge of a jointing material on an electrode very thinly, are the junction method characterized by joining all the charges of a jointing material by an intermetallic compound layer diffusion and by pressurizing and heating until it makes it intermetallic-compound-ize after position ****, and / according to this method] A reliable junction can be obtained without applying load very short [time / for diffusing the charge of a jointing material].

[Translation done.]